Table 1. CSBP Metrics Used to Describe BMI Community Structure

Metric	Description	Expected Response to Impairment
Richness Measures		
Cumulative Taxa	Total number of individual organisms	decrease
EPT Taxa	Number of taxa in the Ephemeroptera, Plecoptera, and Trichoptera insect orders	decrease
Ephemeroptera Taxa	Number of mayfly taxa (genera)	decrease
Plectoptera Taxa	Number of stonefly taxa (genera)	decrease
Trichoptera Taxa	Number of caddisfly taxa (genera)	decrease
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly, and caddisfly larvae	decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly, and caddisfly larvae with Tolerance Values of 0 through 3	decrease
Shannon Diversity Index	General measures of sample diversity that incorporates richness and evenness	decrease
Tolerance/Intolerance Measures		
Tolerance Value	Value between 0 and 10, weighted by abundance of individuals designated as pollution tolerant (lower values)	increase
Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1, or 2	increase
Percent Tolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 8, 9, or 10	increase
Percent Hydropsychidae	Percent of organisms in the caddisfly family, Hydropsychidae	increase
Percent Baetidae	Percent of organisms in the mayfly family, Baetidae	increase
Percent Chironomidae	Percent of organisms in the true fly family, Diptera	increase
Percent Dominant Taxa	Percent composition of the single most abundant taxon	increase
Functional Feeding Groups		
Percent collectors	Percent composition of taxa that collect or gather fine particulate organic matter	increase
Percent filterers	Percent composition of taxa that filter fine particulate organic matter	increase
Percent scrapers	Percent composition of taxa that graze upon periphyton	variable
Percent predators	Percent composition of taxa that feed on other organisms	variable
Percent shredders	Percent composition of taxa that shreds coarse particulate matter	decrease

Table 2. Ranges of CSBP Metrics for BMI Communities from Riffle Stations, by Geographic Area

	Entire Study Area	Stream Reaches Upstream of Oroville Reservoir Inundation Zone	Oroville Reservoir Inundation Zone	Feather River between Fish Barrier Dam and Thermalito Afterbay Outlet[1]	Feather River between Fish Barrier Dam and Thermalito Afterbay Outlet[2]	Feather River downstream from Thermalito Afterbay Outlet to Honcut Creek[1]	Feather River downstream from Thermalito Afterbay Outlet to Honcut Creek[2]	Lower Feather River downstream from Honut Creek
Number of Sites	33	7	1	6	8	3	4	3
Cumulative Taxa	16-49	31-49	19	20-32	20-35	16-24	18-28	22-24
EPT Taxa	4-29	12-29	4	7-11	6-14	7-13	8-13	10-15
EPT Index (%)	5-95	10-68	47	5-69	11-81	67-84	46-95	68-84
Shannon Diversity Index	0.9-2.7	2.0-2.7	1.8	0.9-2.4	1.5-2.2	1.6-2.0	1.7-2.1	1.6-2.1
Tolerance Value	3.0-6.0	3.9-5.7	4.6	4.7-6.0	3.1-4.8	4.4-4.7	3.0-4.4	4.5-4.7
%Hydropsychidae	0-48	0-21	38	1-25	0-35	45-48	10-41	3-26
% Baetidae	3-57	3-27	7	1-42	7-55	14-31	11-47	42-57
% Chironomidae	3-83	9-54	30	10-83	3-54	8-18	3-48	8-24
% Collector	26-95	37-68	42	35-90	53-95	33-42	26-86	60-88
% Filterer	0-73	1-36	43	6-40	0-46	46-51	13-73	4-30
% Grazer	0-46	9-44	2	0-46	0-35	6-17	0-3	6-8
% Predator	0-12	0-12	12	3-10	0-2	1-2	not found	1-5
% Shredder	0-6	0-6	not found	none found	0-2	not found	0-4	not found

1 Computed from DWR samples
2 Computed from CSU-Chico samples

Table 3. Ranges of CSBP Metrics for BMI Communities from Deep-water Stations, by Geographic Area

	Entire Study Area	Feather River between Fish Barrier Dam and Thermalito Afterbay Outlet	Oroville Wildlife Area	Lower Feather River downstream of Honcut Creek	Sacramento and Yuba Rivers
Number of Sites	6	1	1	2	2
Cumulative Taxa	3-15	10	6	3	3-15
EPT Taxa	0-3	1	1	0-1	0-3
EPT Index (%)	0-30	1	2	0-2	0-30
Shannon Diversity Index	0.5-1.8	1.3	1.0	0.5-0.8	0.7-1.8
Tolerance Value	5.8-6.4	6.4	5.8	5.9-6.0	5.8-5.9
%Hydropsychidae	0-1	1	not found	not found	not found
% Baetidae	not found	not found	not found	not found	not found
% Chironomidae	1-79	1	61	13-37	19-79
% Collector	15-94	78	94	15-37	75-86
% Filterer	0-85	17	not found	58-85	0-14
% Grazer	0-5	not found	not found	0-5	0-1
% Predator	0-24	5	6	not found	0-24
% Shredder	not found	not found	not found	not found	not found

Table 4. Total Counts of Major Phytoplankton Taxonomic Groups by Geographic Area, 2002

	Geographic Area				
Organism Type	**Entire Study Area**	**Oroville Reservoir**	**Thermalito Complex**	**Downstream of Oroville Dam**	**Oroville Wildlife Area**
Number of Sites	14	5	4	2	3
Blue-green	322	89	70	9	78
Cryptomonads	312	81	63	9	76
Diatoms	1,563	578	834	50	83
Dinoflagellates	60	20	5	4	18
Euglenoids	31	11	1	1	13
Flagellates	248	17	14	4	4
Greens	411	76	96	25	209
Yellow-browns	135	81	46	3	5
Yellow-greens	489	3	0	0	0
TOTAL	**3,571**	**956**	**1,129**	**105**	**486**

Table 5. Average Zooplankton Densities (number per liter) in Oroville Reservoir in Different Months during May, 2002 through January, 2004

Taxonomic Group	Scientific Name	May, '02	Jul., '02	Aug., '02	Sep., '02	Oct., '02	Nov., 02	Jan., '03	Jul., '03	Sep., '03	Oct., '03	Nov., '03	Jan., '04
	Number of Sites	2	1	1	2	2	3	1	1	1	1	1	1
Cladocera	*Bosmina longirostris*	0.01	0.22	1.08	3.77	3.63	0.46	2.65	0.59	0.59	2.30	0.49	0.42
	Daphnia pulex	4.91	0.00	0.00	0.00	0.00	0.00		0.29	3.24	1.03	0.29	0.17
	Daphnia rosea	0.49	0.00	4.90	0.29	0.59	0.02	0.10	0.00	0.00	0.00	0.00	0.00
	Daphnia galeata mendotae	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Daphnia sp.	0.00	0.05	0.00	0.00	0.02	0.12	0.00	2.55	0.78	0.00	2.06	1.15
	Diaphansoma birgei	0.00	0.00	0.59	2.01	0.25	0.00	0.00	0.00	0.00	0.05	0.00	0.00
	Leptodora kindti	0.00	0.00	0.20	0.10	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL	**5.45**	**0.27**	**6.76**	**6.18**	**4.53**	**0.60**	**2.75**	**3.43**	**4.61**	**3.38**	**2.84**	**1.74**
Copepoda	*Cyclops sp.*	2.09	0.17	0.98	2.06	1.81	1.47	5.10	8.33	23.33	5.59	2.94	1.15
	Leptodiaptomus tyrrelli	0.21	0.22	4.02	8.28	0.20	0.15	1.08	0.69	0.69	0.34	0.69	0.05
	Nauplii	5.82	0.52	6.57	13.14	0.78	1.77	9.61	9.22	12.65	2.99	11.18	1.91
	TOTAL	**8.12**	**0.91**	**11.57**	**23.48**	**2.79**	**3.39**	**15.78**	**18.24**	**36.67**	**8.92**	**14.80**	**3.11**
Rotifers	*Asplanchna sp.*	1.92	3.28	1.86	1.67	2.70	0.88	3.33	0.00	0.00	0.00	0.00	0.00
	Kellicottia longispina	0.60	0.10	0.20	0.07	0.02	0.03	0.78	2.26	1.57	0.00	1.86	0.32
	Keratella cochlearis	0.08	0.78	5.10	12.06	18.38	4.89	9.71	2.45	55.59	16.72	36.18	0.27
	Keratella quadrata	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.71	2.06	0.83	8.33	0.76
	Lecane sp.	0.00	0.00	0.00	0.91	2.35	0.07	0.00	0.00	0.00	0.00	0.00	0.00
	Polyarthra sp.	0.40	0.27	0.00	1.03	13.83	4.24	8.04	0.00	0.00	0.00	0.00	0.00
	Tichocerca sp. 1	0.00	0.00	7.75	4.44	0.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00
	Tichocerca sp. 2	0.00	0.00	0.98	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	TOTAL	**2.99**	**4.44**	**14.90**	**20.17**	**37.28**	**10.59**	**21.86**	**9.41**	**59.22**	**17.55**	**46.37**	**1.35**

Table 6. Matrix of Impacts to BMI Community from Current Project Operations

Current Impacts	Geographic Area(s)	Current Operations (Baseline)	General Impact Description	Directional Impact Assessment
Ramping in Feather River below Thermalito Afterbay Outlet	Feather River below Thermalito Afterbay Outlet	Flow changes under 2,500 cfs are to be reduced by no more than 200 cfs during any 24-hour period, except for flood management, failures, etc.	Taxa richness and community diversity in HFC is comparable to that in LFC, which is much less affected by flow variations.	Neutral
Minimum instream flow	Feather River between Fish Barrier Dam and Thermalito Afterbay Outlet (LFC)	The Oroville Facilities are operated to release a minimum of 600 cfs into the LFC for fisheries purposes.	Dampening the Feather River hydrograph theoretically has limited annual flushing flows that occurred naturally, thus allowing macroinvertebrates more favorable characteristics for colonization and expansion.	Positive
Managed flow downstream from Thermalito Afterbay Outlet	Feather River downstream of Thermalito Afterbay Outlet	Below Afterbay, 1,700 cfs from October through March, and 1,000 cfs from April through September during average water years.	Minimum instream flows have resulted in altered temperature regimes in the Feather River and altered geomorphic processes. However, macroinvertebrate communities are similar in diversity and composition across most sites in the Feather River below Fish Barrier Dam.	Neutral
Armored substrate	Feather River between Fish Barrier Dam and Thermalito Afterbay Outlet (LFC)	Substrates in some parts of this reach have become armored.	Areas of armored substrate provide limited habitat complexity and thus are associated with macroinvertebrate assemblages that are less diverse.	Negative
Temperature Regime Altered from Natural Conditions	Feather River between Fish Barrier Dam and Thermalito Afterbay Outlet (LFC)	DWR is required to control water temperature at RM 61.6 (Robinson's Riffle) from June 1 through September 30. This measure requires water temperatures less than or equal to 65°F on a daily average.	Lower water temperatures during summer for the benefit of anadromous fishes could delay macroinvertebrate reproduction and growth, and affect community composition. Although lower water temperatures likely would be within temperatures historically present in Feather River, altered temperature regimes could favor individual species or communities that are different from natural conditions.	Negative
Fish Stocking	Feather River below dam; OWA; Thermalito Complex	Salmonids are released from the Feather River Fish Hatchery into the Feather River.	Based on ecological principles, increased abundance of predators could be expected to result in lower macroinvertebrate densities, long-term shifts in macroinvertebrate size from selective predation, and shifts in community composition.	Negative

Table 7. Matrix of Impacts to BMI from Potential Effects of Resource Actions

Potential Impacts	Geographic Area(s)	Current Operations (Baseline)	General Description of Proposed Actions	General Impact Description	Directional Impact Assessment
Alter ramping rates in Feather River below Oroville Dam	Lower Feather River	Flow changes under 2,500 cfs are to be reduced by no more than 200 cfs during any 24-hour period, except for flood management, failures, etc.	Provide pulsed flows above existing levels for benefit of fish migration. Target flow magnitudes and timing of flow pulses have yet to be determined.	No net change from baseline impacts expected as pulsed flows presumably would be increased according to current ramping requirements	Neutral
Change flow magnitude in Feather River below Oroville Dam	Lower Feather River upstream of Thermalito Afterbay Outlet	The Oroville Facilities are operated to release a minimum of 600 cfs into the Feather River from the Thermalito Diversion Dam for fisheries purposes.	Incrementally increase flows in the reach between Fish Barrier Dam to Thermalito Afterbay Outlet from relatively low flows to relatively high flows for the benefit of Chinook salmon.	Increasing flow would inundate additional spawning gravels, aid in fish spawning and incubation, and create more BMI habitat.	Positive
Gravel Replenishment	Feather River between Oroville Dam and Thermalito Afterbay Outlet	Substrates in some parts of the reach between Fish Barrier Dam and Thermalito Afterbay Outlet have become armored.	Spawning gravel quality would be improved in target sections of the reach between Fish Barrier Dam to Thermalito Afterbay Outlet for the benefit of spawning salmon.	Improving spawning gravel quality in target areas of the reach between Fish Barrier Dam and Thermalito Afterbay Outlet would result in areas with large cobble substrates that previously were armored. Depending on the number and size of target areas, improved substrate quality would provide a benefit to BMI diversity and community structure (via improved habitat for recolonization).	Strongly Positive

Table 7. (continued)

Potential Impacts	Geographic Area(s)	Current Operations (Baseline)	General Description of Proposed Actions	General Impact Description	Directional Impact Assessment
Side-channel Restoration	Lower Feather River upstream of Thermalito Afterbay Outlet	Availability of side channel habitat has been affected by levees and project operation.	Side channels would be created or enhanced to provide habitat for rearing salmonids.	Increasing the quantity and quality of side channel habitat in the lower Feather River also provides a habitat benefit for BMI. Depending on the number and size of target side-channel areas, increased habitat would provide a benefit to BMI diversity and abundance in this reach.	Strongly Positive
Temperature	Lower Feather River	DWR is required to control water temperature at Feather River mile 61.6 (Robinson's Riffle) from June 1 through September 30. This measure requires water temperatures less than or equal to 65°F on a daily average.	Increased amounts of water would be released into the LFC to decrease water temperatures and increase spawning habitat for the benefit of salmonids.	Lower water temperatures in the LFC could affect BMI reproduction, growth, and community composition; however, lower water temperatures likely would be within temperatures historically present in Feather River.	Negative
Fish Stocking	Lower Feather River; OWA; Thermalito Complex	Salmonids are released from the Feather River Fish Hatchery into the Feather River.	Warmwater species, such as bass, would be stocked into target areas within the Thermalito Complex and OWA, and salmonids would be released in higher numbers into the Feather River.	Based on ecological principles, increased abundance of predators could be expected to result in lower BMI densities, long-term shifts in BMI size from selective predation, and shifts in community composition.	Negative
Upstream fish transport	Above Lake Oroville	Oroville Dam prevents upstream fish passage into tributaries where salmon historically spawned.	Transport salmon that have returned to the Feather River below Oroville Dam to upstream tributaries.	Transporting live salmon to tributaries of Lake Oroville during spawning could result in ecological benefits (e.g., marine-derived nutrients) and thus benefits to BMI communities would be realized.	Positive

Table 8. Matrix of Impacts to Plankton from Current Project Operations

Potential Impacts	Geographic Area(s)	Current Operations (Baseline)	General Impact Description	Directional Impact Assessment
Water temperature increase	Thermalito Afterbay, Lake Oroville	The Thermalito Afterbay is managed to provide water that meets temperature criteria and instream flow requirements in the Feather River. The Thermalito Afterbay also is operated to meet the needs of agricultural diverters. Lake Oroville is operated primarily for flood control, water supply, and power production.	Water temperature increases from project operations likely result in increased plankton production, although plankton communities are seasonally variable and highly dynamic, affected by predator feeding rates, and are limited by nutrient availability. Specific shifts in community structure or species abundance are difficult to predict because of confounding environmental variables.	Neutral
Habitat Enhancement for Warmwater Species	Lake Oroville	DWR currently enhances habitat in Lake Oroville for warmwater species.	Increasing levels of fish predation likely alter plankton communities and decreases overall plankton abundance.	Negative

Table 9. Matrix of Impacts to Plankton from Potential Effects of Resource Actions

Potential Impacts	Geographic Area(s)	Current Operations (Baseline)	General Description of Proposed Actions	General Impact Description	Directional Impact Assessment
Side Channel Restoration	Feather River between Oroville Dam and Thermalito Afterbay Outlet	Existing side channels have been affected by levees and project operation.	Side channels would be created or enhanced to provide habitat for rearing salmonids.	Increasing side channel habitat would increase availability of side pool habitat for plankton.	Strongly Positive
Increase water level in Thermalito Afterbay	Thermalito Afterbay	The Thermalito Afterbay is managed for pump-back operations and to provide water that meets temperature criteria and instream flow requirements in the Feather River. The Thermalito Afterbay also is operated to meet the needs of agricultural diverters.	Increase water level in Thermalito Afterbay for benefit of waterfowl and warmwater fish production.	Increased volume of water would be available for plankton production.	Positive
Water temperature increases	Thermalito Afterbay	The Thermalito Afterbay is managed for pump-back operations and to provide water that meets temperature criteria and instream flow requirements in the Feather River. The Thermalito Afterbay also is operated to meet the needs of agricultural diverters.	Water temperatures would be increased in the Thermalito Afterbay for the benefit of agricultural users.	Increased water temperature could lead to increased plankton production, but if nitrogen is limited, warmer temperatures would likely favor blue-green algae, which are undesirable.	Negative
Nutrient Increases	Lake Oroville tributaries	Based on studies conducted in tributaries upstream of Lake Oroville, nutrient concentrations (i.e., Nitrogen, Phosphorus, Organic Carbon) are below nuisance levels.	Adult salmonids would be transported to upstream tributaries for spawning.	Increasing nutrients in tributaries would slightly increase nutrient concentrations in these areas.	Positive
Chemical treatment of ponds	OWA	OWA ponds are not managed to curtail proliferation of exotic species or plants that can be detrimental to fish and waterfowl production (e.g., water primrose).	Target OWA ponds would be chemically treated to eliminate undesired aquatic plant species.	Increasing levels of fish predation via chemical treatment of OWA ponds could alter plankton communities and increase overall plankton abundance.	Positive

Table 9. (continued)

Potential Impacts	Geographic Area(s)	Current Operations (Baseline)	General Description of Proposed Actions	General Impact Description	Directional Impact Assessment
Fish Stocking	OWA, Thermalito Afterbay, Lake Oroville	DWR currently enhances habitat in Lake Oroville for warmwater species. DWR does not manage Thermalito Afterbay or OWA for trophy warmwater fishery.	DWR would mange Thermalito Afterbay and OWA for trophy fishery. Lake Oroville fish stocking efforts would continue, and salmon would be stocked in Lake Oroville tributaries.	Increasing levels of fish predation via stocking could decrease overall plankton abundance, but it could also reduce abundance of small fish and macroinvertebrates that prey on plankton, which could result in increased plankton abundance.	Neutral